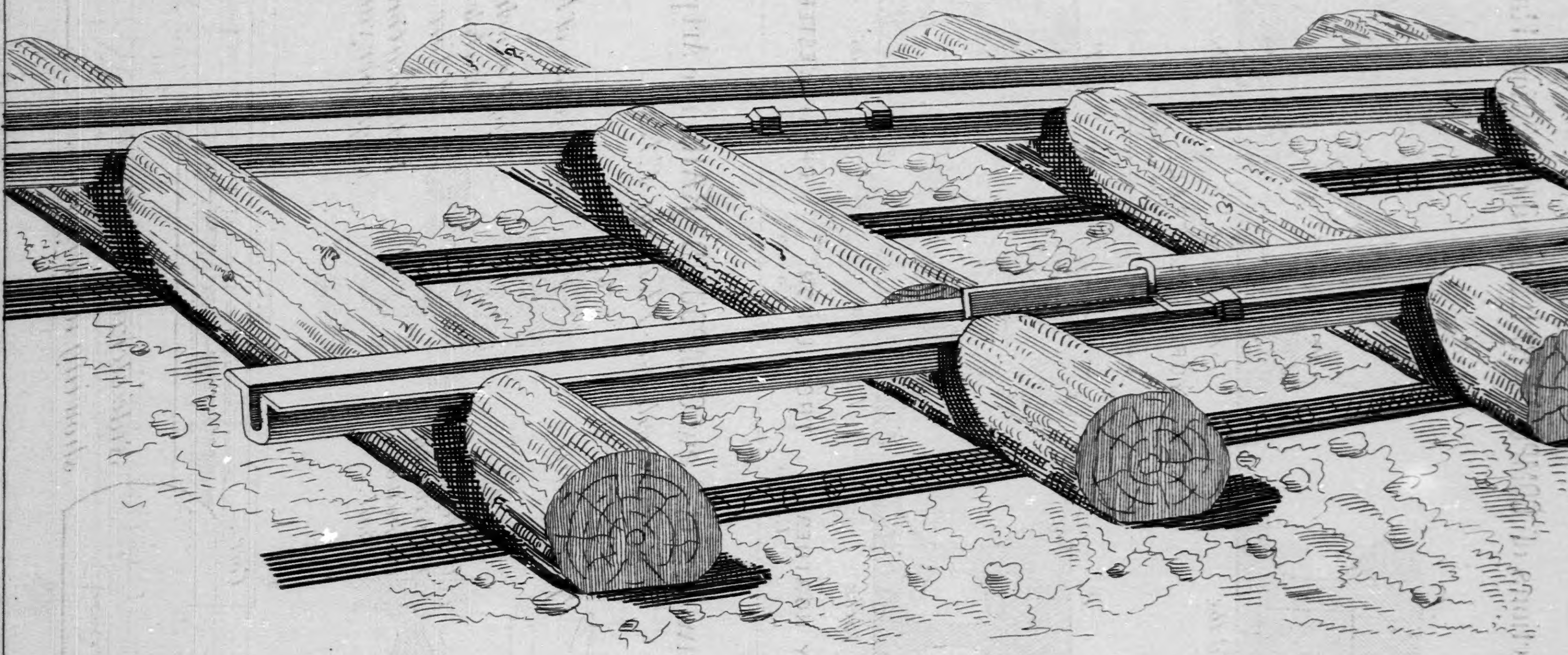
1886 F 5

R. Bell

New Compound Rail

Sketch showing an Improved COMPOUND RAIL designed by Sandford Fleming. C.E.



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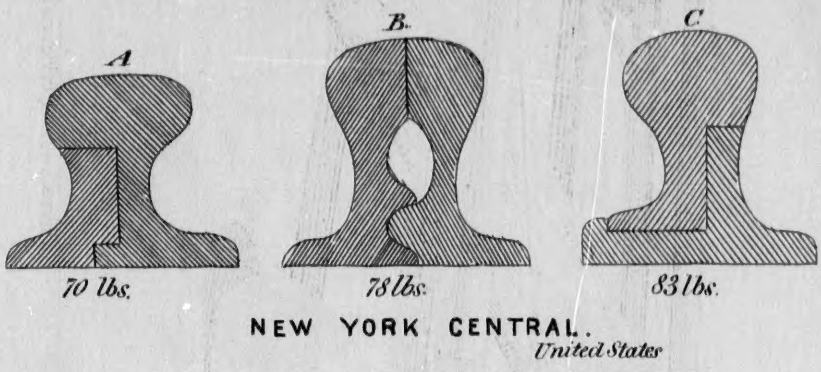
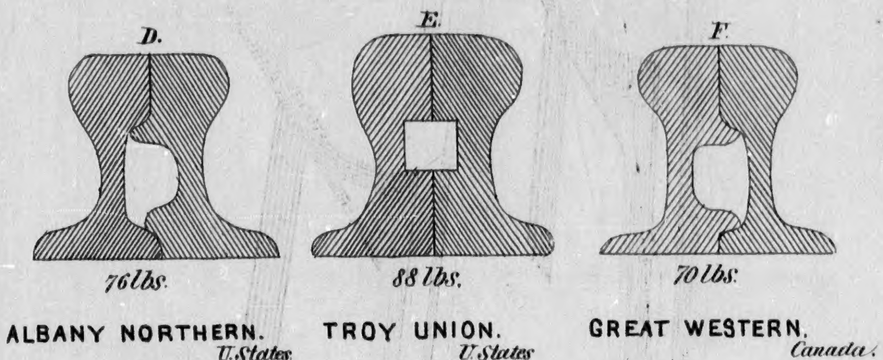
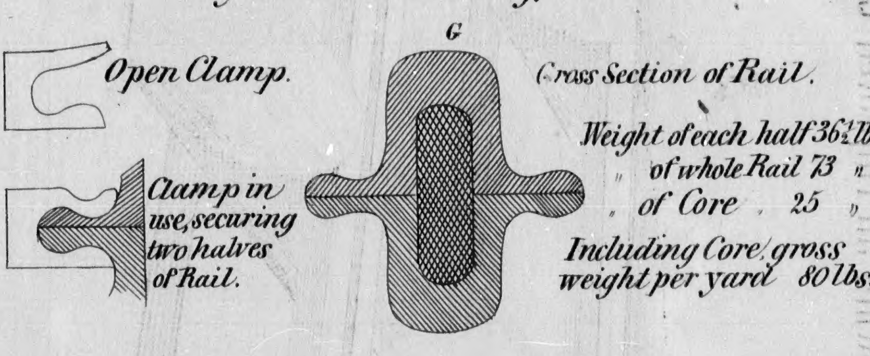
Sections of COMPOUND RAILS tried on Various Railways.

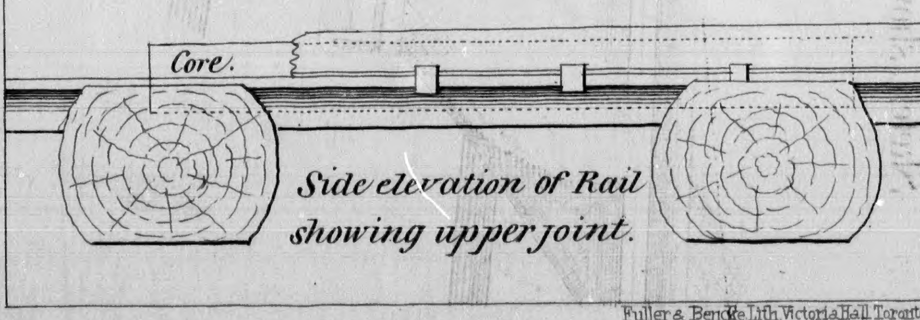




Drawings of New COMPOUND RAIL see Art page 273.

by Sandford Fleming, C.E.





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NEW COMPOUND RAIL.

BY SANDFORD FLEMING, C.E.

The improvement on railway construction now referred to consists in forming a continuous rail, of uniform strength throughout its length, by means of two light bridge rails, placed the one over the other, and breaking joint. The lower rail is inverted, and rests in grooves cut in the ties or sleepers to receive it; the upper rail is placed immediately over the lower one and secured to it by means of clamps or bolts; wrought iron cores are inserted in the internal cavities at each of the joints, for the double purpose of giving vertical strength and locking the two halves so as to prevent any lateral motion.

The necessity of improving the mode of constructing "The Permanent Way" has doubtless forced itself upon the attention of those who daily witness the care and labour bestowed on the rail track to maintain it in a serviceable state, and more especially of railway proprietors, who too frequently learn at their annual meetings that the earnings of the company are very largely absorbed in the account headed, "Track Repairs" or "Maintenance of Way."

The annual cost of keeping in efficient repair what is termed "The Permanent Way" of railways is very great. It is found, when proper allowances are made for the deterioration of the iron rails and destruction of the ties or sleepers, to amount to about half as much as all the

other expenses of the company. When we consider the large sums necessarily required for repairs of engines and rolling stock generally, repairs of buildings and fences, management, salaries, office and station expenses, fuel, oil and waste, legal expenses, damages, taxes, &c., it appears not a little astonishing that the cost of keeping the iron rails in a proper state of safety and usefulness should bear such a large proportion to the gross expenditure on those various services.

That the maintenance of the permanent way, forming such a heavy charge against the revenue of a company, indicates some defect in its construction, is quite within the bounds of possibility; it at least leaves an opening for enquiry, if not for some improvement, in that portion of a railway which is permanent only in name.

For some years back an endless variety of plans have been invented to render more perfect this essential part of railways. Many of them have been tried with various degrees of success, while not a few have, by common consent, remained the useless property of their originators. The plan now submitted may form an addition to the long list of those last mentioned, although I am not without hopes that on a consideration of the advantages which it appears to possess, it may justify the cost of a practical test, and perhaps be a means not only of enhancing the comfort and safety of railway travellers, but also of assisting in some degree to make railways pay, by reducing the present heavy cost of maintenance.

It is of vast importance to ascertain the weak and defective points of existing systems of "permanent way," since, by so doing, we know where remedies should be applied. Experience shows that the ordinary rail track is defective in one essential principle, inasmuch as its continuity of strength is broken at the ends of every rail bar. The joints being deficient in the requisite strength, they are affected more than other parts of the rail bars by the weight and percussive shocks of passing loads, the ballast underneath yields from the unequal pressure, the chairs and spikes at these points constantly get broken and displaced, and as a consequence the whole track, without frequent inspection and repairs, rapidly becomes deranged. The climate of this country too, I am constrained to believe, tells much more severely on the permanent way, as at present constructed, than it does in England. The frost enters the ground to a great depth, and results at certain seasons in softening the substratum. Thereupon a depression of the ballast under the weight of train, and a vertical work-

ing of the rail ends at the joints take place, in consequence of which the rails are subjected to percussive blows, the chairs not unfrequently are broken, the spikes drawn, and the whole track is liable to be injuriously thrown out of line and level. This circumstance of climate goes to prove the necessity of a more perfect system of permanent way in this country than where the seasons are more temperate. And hence we may account for the otherwise remarkable fact, that America when compared with England has been so much more prolific in compound rails, and similar expedients, to remedy the objections above named.

Amongst other expedients which have been tried to lessen the evils referred to, the application of fishing plates at the joints has been found, when they are kept in perfect order, to answer an excellent purpose. The fishing plates, however, are liable to get deranged, as the bolts by which they are fastened readily become loose through the vibration of the rails, and in this state they are of little service. When this expedient was discussed at a meeting of the Institution of Civil Engineers held last year in England, it was stated that "a recent examination of some brackets and fish plates which had been laid down about twelve months, and were secured by bolts and nuts, showed, that in 125 pairs of joints, each pair having 8 bolts, 261 bolts were loose, and 6 were out altogether, though they had been tightened up within 48 hours. The number of loose bolts at each joint varied from 1 to 8. It was contended, therefore, that bolts and nuts, such as were ordinarily used, were unsafe, inefficient, and expensive fastenings for connecting together the parts of a permanent way, and that they were not to be relied on."

Compound rails of various kinds have been tried of late years on some American roads to overcome the defects of the ordinary rail track. They have been found, when newly laid and in good order, to be remarkably smooth to ride over, and easy on the engines and rolling stock, but as the plan of their construction required that they should be secured with the same description of fastenings as those used with the fishing plates above referred to, they soon got out of order, were difficult and expensive to keep in repair, and are now, I believe, but little used. The Plate shows different patterns of compound rails which have been tried, six on American railways and one on the Great Western in Canada. They are all, with slight modifications, designed after the same general plan, that is, two halves joined together vertically, breaking joint longitudinally, and fastened with bolts and nuts.

It is evident that the joints of these rails, forming as they do a series of long scarfs, must be very much stronger and better than the common chair joints, but still the joints are not so strong as the body of the rails, since at the points where they occur one half only of the sectional area of the rail is solid. If there had been no other objection to these compound rails than the absence of as much strength at the joints as elsewhere, they would, no doubt, be more generally in use than we find them, inasmuch as in them the weak and defective part of the common rail is very materially remedied. Experience, however, has demonstrated that all these patterns of rails are open to serious objections, the most important of which may be stated as being increased first cost over the common rail, excessive cost of maintenance, and too rapid wearing out.

It is evident that these objections may readily be attributed to the plan of construction, as the application of bolts or rivets throughout the entire length of the rail is indispensable to hold the two halves together. As already explained, bolts cannot be relied on, inasmuch as they constantly shake loose, and in this state the stability of the rail is impaired. It is found, too, that rivets for other reasons are perhaps even more objectionable, and whether bolts or rivets are used it is not long before laminated portions of the upper surface of the rail get in between the two plates, and these acting like small wedges, and driven tight by every passing train, gradually open up the rail and hasten its destruction. It is found, moreover, that unless the bolts are properly performing their duty, the whole weight of trains not unfrequently comes on a single half of the rail, producing violent strains which soon tell on the durability of the several parts. For these reasons such compound rails as have been already tried have not proved economical in maintenance, and in consequence have fallen into disuse.

The design of the compound rail now submitted may be executed of any required weight which a heavy traffic might demand. It is thought, however, that a good serviceable rail may be made weighing 80 lbs. per yard including wrought iron cores, the cores themselves weighing 25 lbs., and each half of the rail $36\frac{1}{2}$ lbs. The ties could be grooved by a machine at a trifling cost, and the grooves for both rails could be cut at the same operation; by this means the proper guage of the track would be permanently secured, and the whole superstructure would be laid with the greatest ease and with very little skilled

labour; it would be unnecessary to flatten the ties on any but the lower side, as the machine would form a perfect seat for both rails. The cores may be from $2\frac{1}{2}$ to 3 feet in length, inserted at the joints of both upper and lower half rails, and secured in their position by a small rivet or pin; they would have the same sectional area as each half rail, and being deeper, they would give fully more strength where the joints occurred than the rail possessed at intermediate points.

A permanent way constructed with a compound rail similar in design to the one now submitted may, when put on its trial, have some inherent defects which we cannot at present discover, but in the absence of a practical test, and in ignorance of any strong objection to the plan proposed, I think it may fairly claim the following advantages:

1st. Simplicity of construction and fewness of parts.

2nd. Sufficiency of lateral as well as vertical strength at every point.

3rd. Could be easily laid in perfect guage with little skilled labour.

4th. The rails would be equivalent to continuous bars of uniform strength, and probably would be found more elastic than solid rails.

5th. Great stability, the rails being securely bedded in the ties and their surfaces reduced to the least vertical height practicable above the ballast.

6th. The rails would be thoroughly secured from spreading or displacement.

7th. The track would be smooth to ride over, free from jolts or jars, and easy on the rolling stock.

8th. Economy in cost and maintenance.

Some of these advantages will be readily admitted on a simple inspection of the drawings, others may be inferred from previous explanations, but the last, which is in fact the most important of all, requires some further observations.

Those who have had opportunities of overlooking the operations of the workmen engaged in track repairs must have observed that a great portion of their time is occupied in restoring the injury done to the rail joints, eith in removing broken chairs, tightening bolts, or raising the ballast and ties,—indeed at some seasons of the year the most of their time is occupied in raising the joints. With the improved rail

this could not be the case, as practically it has no joints, being of uniform strength throughout its length. In this view of the case I cannot be far astray in estimating, that the improved rail compared with the common rail would not require more than half the number of track men to keep it in repair, and that in this service a saving of not less than $120 per mile would annually be effected.

Again, the ends of the common rail bars laid in the ordinary way, being deficient in strength, are invariably the first portions of the iron to laminate and give way, it may very reasonably be argued that the wearing surface of the improved rail, being equally supported at all points, would not be so much exposed to percussive blows and unequal wear as the common rail, and would, as a natural consequence, last longer. However just this conclusion may be, it will at once be apparent, that the improved rail may undoubtedly claim very much greater durability and usefulness for other reasons. The lower half being an exact counterpart of the upper, by simply inverting both when the wearing surface of the upper is destroyed, we have a fresh surface brought into play, which in all probability may last quite as long as the first. In view of both these circumstances we may, in all fairness, claim that the improved rail will serve its purpose not less than double the period that the common rail would endure, and hence the annual deterioration of the latter should be reckoned as being very much greater than the former. To illustrate the financial value of these advantages possessed by the improved rail, I present an approximate estimate of the annual saving it would effect.

Assuming that the improved rail, including wrought iron cores, weighs 80 lbs. per yard, and that the common rail weighs 65 lbs. per yard exclusive of chairs, the first cost of a rail track constructed with the former will exceed one with the latter by about $800 per mile :

	Annual excess per Mile of Improved Rail over Common.	Annual excess per Mile of Common Rail over Improved.
Annual interest on $800 excess in first cost of improved Rail	$48	
Annual exess of cost of track repairs..................	....	$120
Annual excess of deterioration of iron rails..........	....	260
	$48	380
Saving per mile per annum in favor of Improved Rail...	....	$332

It is not pretended that the above estimate is perfectly correct and adapted to every case, as the amount and character of the traffic engaged in by any particular line, as well as the weight of rails used, would affect the calculations. The figures are sufficient, however, to give a comparison between the existing and the proposed system, and to show roughly the commercial value of the latter. Allowing, if need be, one half of the above estimate for unforeseen possible contingencies, we have still a saving of over $180 per mile per annum; a sum which, if reckoned on the mileage of existing Canadian railways, would be equal to a yearly saving of $320,000, sufficient to pay a dividend of 6 per cent. on $5,400,000 of railway capital.

I need scarcely lengthen these observations in order to show that the suggested improvement appears to possess many important advantages, but as the economic test is after all the true financial standard by which such improvements should be measured, I may add, that as the rolling stock is greatly affected by the condition of the track, and the cost of its repairs is proportionate to the state in which the road is kept, we have in this circumstance another element of saving, inasmuch as the improved rail could doubtless be maintained from first to last in a much smoother state than we usually find existing rail tracks.

If still another illustration be needed to show the economic value of the improved rail, it will be seen in the comparative amount of capital required to re-lay the rails after the first set are worn out. For this comparison it matters not what the average life of a common rail may be considered, since we have already shown that the improved rail may be found serviceable for double the period. Let us assume that the life or serviceable duration of a common rail is 8 years, then that of the improved rail may be taken as 16 years,—before the expiration of 8 years the whole of the former has to be renewed, but the latter being reversible, and a worn out surface being equally good for the lower portion, one half of it only has to be replaced before 16 years expire. In the case of the common rail one-eighth of its first cost should annually be set aside out of the company's earnings to replace it in eight years, while only one thirty-second part of the first cost of the improved rail would be needed as an annual sinking fund to renew the wearing surface in sixteen years As a more practical illustration, take a line of railway 200 miles long, and assume the life of a rail as above given, we find, after making ample allowance for the value of the worn out rails as old iron, that the Company would require to expend

in round numbers the sum of \$600,000 before eight years expire in running the ordinary rail, while about \$300,000 would be sufficient to replace the wearing surface of the improved rail in double the period. In other words, while the renewal of the common rail would prove an annual drain of \$75,000 on the earnings of the Company, the improved compound rail would annually draw upon receipts to the extent of from \$18,000 to \$19,000 only.

It may be observed that the strongest claim which this improvement possesses is, economy in maintenance, and unless this advantage be satisfactorily established the adoption of the system on new or existing lines cannot be hoped for. The fact that railway investments bave almost universally turned out profitless to the stockholders, while the public has received and daily receives unmeasured benefits, is a sufficient reason why all improvements in railway construction or in railway management, should have a tendency to distribute the benefits in a more equitable proportion. The public ought not to have a monopoly of them. The parties who invest their capital in railways should have a fair return for their money and their enterprise ; indeed it would be infinitely more satisfactory to the thinking public to know and feel that they were in the enjoyment of the most perfect system of internal communication without loss or it may be ruin to the proprietors. Railways must be made to pay, or their extension into unoccupied fields must cease, and thus suspend the progress of modern civilization. Before they can pay one of two things is neceesary, either the receipts must be increased or the expenditure diminished. Experience goes to prove that the amount of traffic which centres in any particular railway is limited by variable local circumstances and the laws of commerce, and beyond this limit the traffic cannot safely be forced ; if the earnings cannot be increased beyond what the limit of traffic will allow, then, to make the enterprise pay, a reduction of expenditure must be attempted. In this latter respect it is thought that the change now proposed in the construction of the permanent way has every appearance of being one step in the proper direction, and I avail myself of the facilities furnished by the Canadian Institute for giving such publicity to the proposed plan as may bring it under the notice of those most interested in the removal of the evils which it is designed to avert.

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